



Europäisches
Patentamt

European
Patent Office

Office européen
des brevets

10/521529
PCT/EP03/07787

13.08.03

14 JAN 2005

REC'D 01 SEP 2003

WIPO

PCT

Bescheinigung

Certificate

Attestation

Die angehefteten Unterla-
gen stimmen mit der
ursprünglich eingereichten
Fassung der auf dem näch-
sten Blatt bezeichneten
europäischen Patentanmel-
dung überein.

The attached documents
are exact copies of the
European patent application
described on the following
page, as originally filed.

Les documents fixés à
cette attestation sont
conformes à la version
initialement déposée de
la demande de brevet
européen spécifiée à la
page suivante.

Patentanmeldung Nr. Patent application No. Demande de brevet n°

02077912.0

**PRIORITY
DOCUMENT**
SUBMITTED OR TRANSMITTED IN
COMPLIANCE WITH RULE 17.1(a) OR (b)

Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets
p.o.

R C van Dijk

BEST AVAILABLE COPY



Europäisches
Patentamt

European
Patent Office

Office européen
des brevets

PCT/EP 03/07787
13.08.03

Anmeldung Nr:
Application no.: 02077912.0
Demande no:

Anmeldetag:
Date of filing: 17.07.02
Date de dépôt:

Anmelder/Applicant(s)/Demandeur(s):

SHELL INTERNATIONALE RESEARCH
MAATSCHAPPIJ B.V.
Carel van Bylandtlaan 30
2596 HR Den Haag
PAYS-BAS

Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
(Falls die Bezeichnung der Erfindung nicht angegeben ist, siehe Beschreibung.
If no title is shown please refer to the description.
Si aucun titre n'est indiqué se referer à la description.)

Forge welding of clad tubulars

In Anspruch genommene Priorität(en) / Priority(ies) claimed /Priorité(s)
revendiquée(s)
Staat/Tag/Aktenzeichen/State/Date/File no./Pays/Date/Numéro de dépôt:

Internationale Patentklassifikation/International Patent Classification/
Classification internationale des brevets:

B23K20/00

Am Anmeldetag benannte Vertragsstaaten/Contracting states designated at date of
filing/Etats contractants désignées lors du dépôt:

AT BE BG CH CY CZ DE DK EE ES FI FR GB GR IE IT LI LU MC NL PT SE SK TR

EPO - D
17 07. 2002

- 1 -

TS 6376 EPC

Peb

(44)

FORGE WELDING OF CLAD TUBULARS

Background of the invention

The invention relates to method for joining clad tubulars by forge welding.

5 Clad tubulars generally comprise a low steel grade base pipe which is lined on the inside and/or outside with a thin layer of a high quality corrosion resistant metal or alloy, such as a stainless steel and/or a high chromium, high nickel alloy. The clad material may be applied as metallurgical bond created by eg. explosive
10 cladding, arc deposition or plasma powder welding or by providing a mechanical bond such as found using eg. tight fit tubing.

Forge welding involves circumferential heating of the pipe ends that are to be joined and subsequently pressing
15 the pipe ends together to form a metallurgical bond.

A large variety of heating technologies may be used to make the pipe ends hot enough such that the metallurgical bond can be made. The heating techniques may involve electric, electromagnetic, induction,
20 infrared, sparking or combinations of these heating methods.

When used in this specification the term forge welding is intended to encompass all techniques which involve circumferential heating of pipe ends and
25 subsequent metallurgical bonding of the heated pipe ends, including welding techniques that are generally known as diffusion welding, amorphous bonding, friction welding, and/or flash butt welding.

It is known from US patents 4,566,625 ; 4,736,084 ;
4,669,650 and 5,721,413 issued to Per H. Moe that it may
be beneficial to flush the pipe ends just before and
during the heating and forge welding operation with a
reducing flushing gas, such as hydrogen or carbon
monoxide, such that any oxide skin is removed from the
heated pipe ends and a metallurgical bond with a minimal
amount of irregularities is obtained. It is also known
from US patents 2,719,207 and 4,728,760 to use non
explosive mixtures comprising about 95% by volume of a
substantially inert gas, such as argon, nitrogen and/or
helium, and about 5% by volume of a reducing gas, such as
hydrogen and/or carbon monoxide for flash welding and
induction butt welding.

Experiments have shown that forge welding techniques
are capable to generate high quality metallurgical bonds
between the tubular ends, in particular if the pipe end
are flushed with a reducing flush gas mixture during the
heating and welding operation, but that the red-hot pipe
ends are generally deformed such that upsets are formed
in the region of the welding zone and that if clad
tubulars are forge welded together the liner becomes
irregular or is at least partly removed in the welding
zone .

It is an object of the present invention to provide a
method for forge welding of clad tubulars wherein the
formation of irregularities and/or cavities of the liner
in the welding zone is minimized.

Summary of the Invention

In accordance with the invention the cross section of
the ends of the tubulars that are to be forge welded
together are assymetric such that, when the heated
tubular ends are pressed against each other, the

claddings touch each other first before the ends of the base pipes touch each other.

5 Preferably a flushing gas is flushed around the welding zone during the forge welding operation and at least part of the flushing gas is injected into the welding zone from the uncladded side of the tubular, such that the injected flushing gas can still reach the ends of the still spaced base pipes after the claddings have touched each other.

10 In another embodiment special end preparation is required when cladding to ensure that a continuous layer of cladding material is deposited around the end of the pipes to be joined such that the required weld preparation may be cut into only cladded material.

15 However this has the disadvantage in that additional time and materials are required during cladding operations and, further, if the ends of the specially prepared pipe then have to be removed it may not be possible to re-apply this cladded layer. This is especially likely to be true if welding is being carried out away from a workshop at a location such as a rig, pipe-laying barge etc.

20 Furthermore it is preferred that the flushing gas is a reducing flushing gas which removes any oxidised skin from the heated tubular ends such that the amount of oxidised inclusions between the forge welded pipe ends is minimized.

25 If the forge welding is carried out in a hazardous areas, such as on an oil and/or gas production platform, it is preferred that the flushing gas is a non-explosive mixture of a substantially inert gas and a reducing gas.

30 In such case the substantially inert gas may comprise helium, argon, nitrogen, and/or carbon dioxide and the reducing gas may comprise hydrogen

and/or carbon monoxide. A preferred non-explosive flushing gas mixture comprises more than 90% by volume of a substantially inert gas and at least 2% by volume of hydrogen.

5 The forge welding method according to the present invention is suitable for joining clad oilfield and/or well tubulars in hazardous areas, such as on a drilling rig or offshore oil and/or gas production platform. In most cases the inner surface of the tubulars
10 will be clad with a corrosion resistant lining, but if desired the outer surface may be clad as well or instead of the inner surface of the tube walls. To increase the contact surface of the forge welded pipe ends and to simultaneously align the pipe ends the end
15 face of one of the tubular ends that are to be welded together may have a substantially convex shape and the end face of the other tubular end may have a substantially concave shape. It is observed that it is known from US patent 4,669,650 to forge weld tapered ends
20 of unclad tubulars and that US patents 4,566,625 and 5,721,413 disclose forge welding of adjacent concave and convex ends of unclad pipes. It is known from Japanese patent application 02-041637 to join clad tubulars by friction welding , wherein the tubular ends
25 are rotated at high speed relative to each other and pressed together and wherein the clad ends are flat and the base pipes form a V-groove so that the clads touch first during the friction welding operation. Friction welding however creates irregular heating and deformation
30 of the pipe end and the rotation creates vibrations which make friction welding unsuitable for joining clad pipes.

Description of preferred embodiments

These and other features, embodiments and advantages of the forge welding method according to the present invention will be described in more detail and by way of example with reference to the accompanying drawings, in which:

Fig.1 is a longitudinal sectional view of a pair of cladded tubular ends just before they are joined by the forge welding method according to the invention; and

Fig.2 is longitudinal sectional view of a pair of cladded tubular ends wherein one end is concave and the other tubular end is convex.

Referring now to Figure 1 there is shown an upper tubular 1 and a lower tubular 2 which each comprise a low grade steel base pipe have an inner cladding of high chromium steel 3.

The tubular ends 4 and 5 are wedge shaped such that the tips of the wedge shaped ends are formed by the claddings 3. This ensures that when the tubular ends are pressed on to each other the claddings 3 touch each other before the ends of the base pipes touch each other. Throughout the forge welding operation a flushing gas is flushed around the tubular ends 4 and 5 and to ensure continuation of the flushing between the tubular ends 4 and 5 after the claddings 3 touch each other, flushing gas is injected onto the uncladded outer surfaces of the tubulars 1 and 2.

Figure 2 shows an embodiment where the lower end of the upper tubular 10 has a generally convex shape and the upper end of the lower tubular 11 has a generally concave shape.

The outer surface of the tubulars 10 and 11 is cladded with a stainless steel lining 12 and the concave

and convex end surfaces are shaped such that the linings 12 touch each other first and that the base pipes touch each other thereafter. In this case a reducing non-explosive flushing gas is injected from the interior of the tubulars and the tubular ends still form a wedge such that the touching zone gradually increases from the outer surface towards the inner surface of the forge welded tubulars. In this way a good bond between the linings 12 is ensured and inclusion of oxides between the welded tubulars 10 and 11 is minimized.

Figure 3 indicates the end of a plain-end pipe 1 which has been clad 3 and which further material compatible with the clad layer has been deposited around the end of the pipe 2 to allow further machining without exposing the base pipe.

11 7 07. 2002

TS 6376 EPC

(44)

C L A I M S

1. A method for forge welding clad tubulars, wherein the ends of the tubulars are tapered such that, when the heated tubular ends are pressed against each other, the claddings touch each other first before the ends of the base pipes touch each other.

2. The method of claim 1, wherein during at least part of the forge welding operation a flushing gas is flushed around the welding zone and at least part of the flushing gas is injected into the welding zone from the unclad side of the tubular, such that the injected flushing gas can still reach the ends of the still spaced base pipes after the claddings have touched each other.

3. The method of claim 2, wherein the flushing gas is a reducing flushing gas.

4. The method of claim 3, wherein the flushing gas is a non-explosive mixture of a substantially inert gas and a reducing gas.

5. The method of claim 4, wherein the substantially inert gas comprises helium, argon, nitrogen, and/or carbon dioxide and the reducing gas comprises hydrogen and/or carbon monoxide.

6. The method of claim 5, wherein the non-explosive flushing gas mixture comprises more than 90% by volume of a substantially inert gas and at least 2% by volume of hydrogen.

7. The method of claim 1, wherein one tubular end has a substantially concave shape and the other tubular end has a substantially convex shape.

8. The method of claim 1, wherein the tubular ends are wedge shaped and the tips of the wedges are formed by the claddings.

9. The method of covering the end of plain-end pipe with clad metal to allow further machining without exposing base pipe.

10. The method of any preceding claim, wherein the tubulars are oilfield and/or well tubulars.

EPC 1

17 07 2002

(44)

- 9 -

TS 6376 EPC

A B S T R A C T

FORGE WELDING OF CLAD TUBULARS

A method for forge welding clad tubulars, wherein formation of irregularities and/or cavities in the cladding in the welding zone is minimized by tapering the ends of the tubulars such that, when the heated tubular ends are pressed against each other, the claddings touch each other first before the ends of the base pipes touch each other.

(Fig.1)

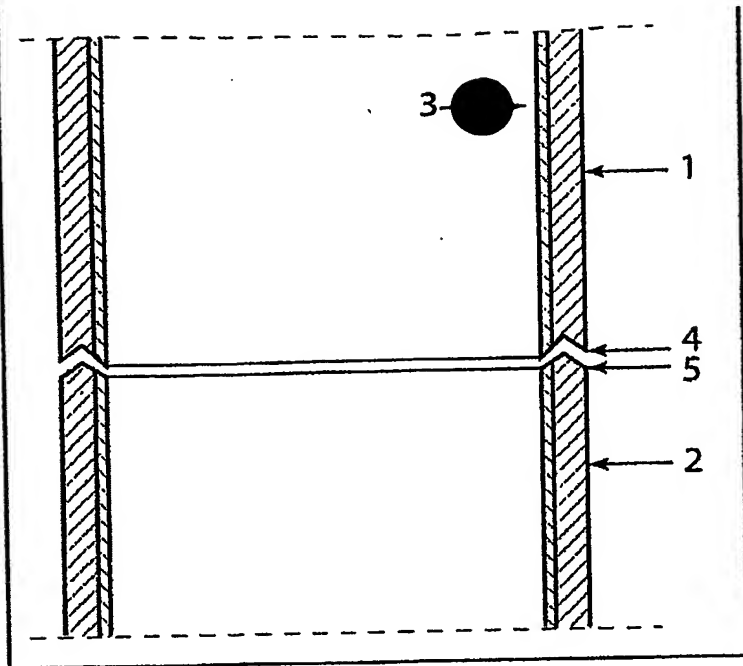


Figure 1



EPO - DG 1
11 7 07. 2002

(44)

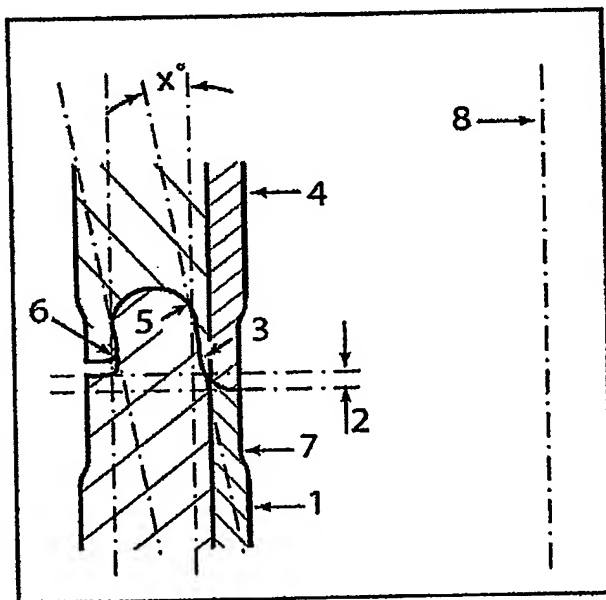


Figure 2a

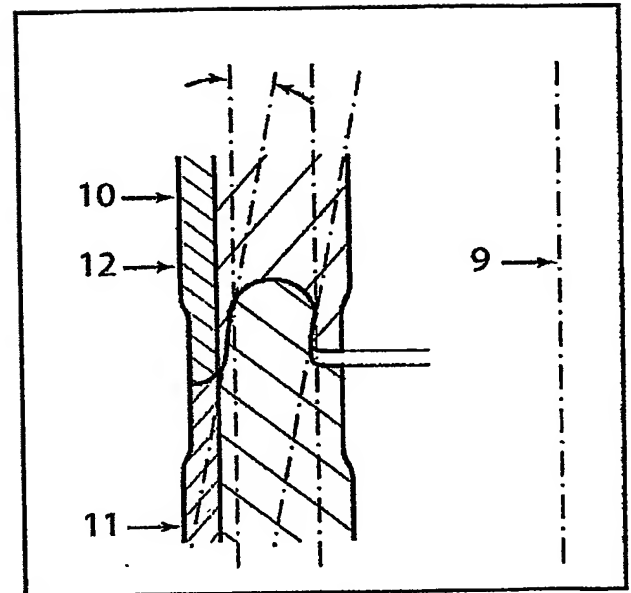
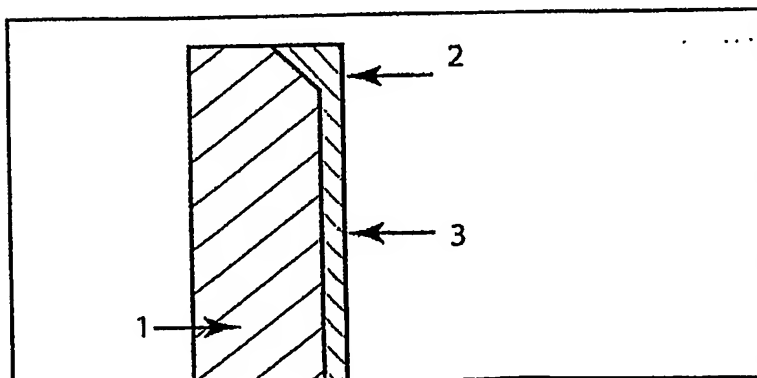


Figure 2b



**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☐ FADED TEXT OR DRAWING
- ☒ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☒ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.